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Joint Council on  
Food and  
Agricultural Sciences

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December 1986

c 4 1986 Accomplishments  
for Research, Extension,  
and Higher Education

A Report to the  
Secretary of Agriculture



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The Joint Council on Food and Agricultural Sciences was established in 1977 to encourage and coordinate research, extension, and higher education activities in the food and agricultural sciences. This role was strengthened in the Agriculture and Food Act of 1981, which directed the Department to improve the planning and coordination of research, extension, and higher education within the public and private sectors and to relate the Federal budget process to the overall functioning of the system. The Joint Council's coordination of science and education activities was reaffirmed in the Food Security Act of 1985.

The Joint Council initiated four reports designed to improve the overall effectiveness of the food and agriculture system.

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A long-term **needs assessment** (20-30 years) for food, fiber, and forest products and the research, extension, and higher education requirements to meet the identified needs. (This task was assigned to the Secretary of Agriculture in the Agriculture and Food Act of 1981. He requested the Joint Council to fulfill this responsibility.) The needs assessment report was prepared and published in two separate documents. One is the *Reference Document: Needs Assessment for the Food and Agricultural Sciences* and the other is the *Summary: Needs Assessment for the Food and Agricultural Sciences*.

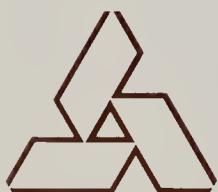
A **five-year plan** to reflect the coordinated goals and objectives of the research, extension, and higher education community. This report was first published in 1984, was updated in 1986, and will be revised biennially.

An **annual priorities report** on research, extension, and higher education, which presents the Joint Council's priorities for the next fiscal year, the required financial support, and suggested Federal, State, and private sector roles. This report will be completed by June 30 of each year.

An **annual accomplishment report** which specifies the ongoing research, extension, and higher education programs and respective accomplishments, along with expectations for the future. This report will be completed by November 30 of each year.

These four reports are interrelated, although each is published separately. They constitute an overall strategic planning process which provides the food and agricultural science system with a means of assessing short-term and long-term future needs and reflecting on past accomplishments. They provide a foundation for planning the most effective and efficient means for meeting the future demands for food, fiber, and forest products. These four reports also offer a continuing mechanism by which the research, extension, and higher education programs can assess future needs.

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*The symbol appearing on the front cover represents the purpose of the Joint Council (i.e., to improve planning and coordination among research, extension, and higher education) and the cooperative character of the food and agricultural science system within Federal, State, and private organizations.*



## Joint Council on Food and Agricultural Sciences

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**Secretariat:**  
Rm. 321 A, Admin. Bldg.  
U.S. Department of Agriculture  
Washington, D.C. 20250

November 30, 1986

Honorable Richard E. Lyng  
Secretary of Agriculture  
Washington, D.C. 20250

Dear Mr. Secretary:

The Joint Council on Food and Agricultural Sciences is required by Section 1407, Public Law 95-113 (as amended by Public Law 97-98) to submit to the Secretary of Agriculture an annual summary on ongoing research, extension, and teaching programs, accomplishments of those programs, and future expectations. We are pleased to submit the 1986 report to you.

This report of the past year's accomplishments of science and education in food and agriculture relates to the priorities identified by the Joint Council and to the goals enumerated in the Five-Year Plan. It also describes the contributions of research, extension, and higher education both to those directly involved in the food and agriculture system and to society in general. The report emphasizes the key role played by the agricultural science and education system in our Nation's progress.

This year's report contains a feature article entitled "Perspectives for U.S. Agricultural Science and Education in a Global Setting" prepared by Dr. C. Eugene Allen of the University of Minnesota. It also highlights more than 50 key accomplishments selected from among nearly three hundred submitted to the Joint Council by the National Agricultural Research Committee, the National Extension Committee and the National Higher Education Committee. Summaries of the activities of the Joint Council and the National Committees and the Regional Councils of the Joint Council are also included.

We look forward to the opportunity of discussing this report with you.

Sincerely,

*Orville G. Bentley*  
ORVILLE G. BENTLEY  
Cochair

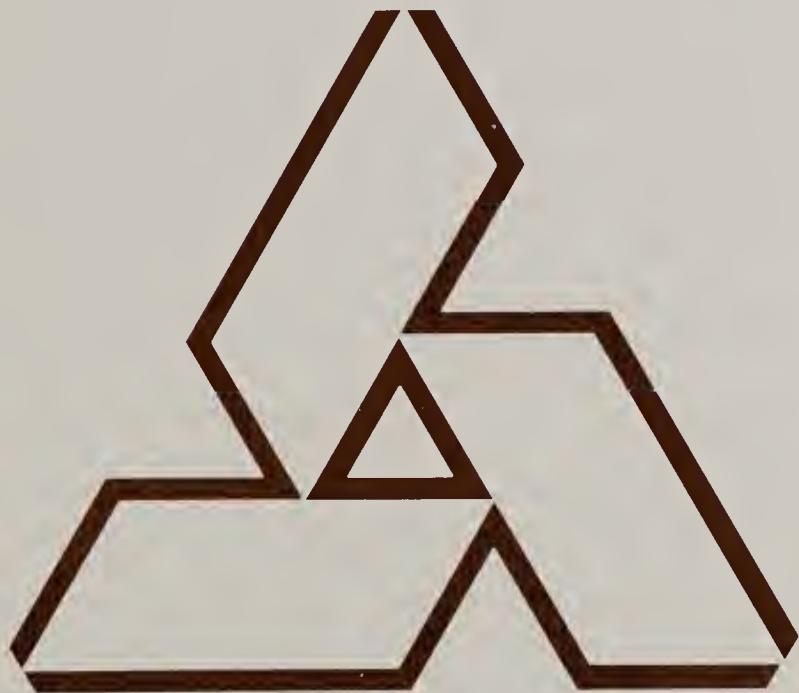
Enclosure

*James H. Anderson*  
JAMES H. ANDERSON  
Cochair



# **1986 Accomplishments for Research, Extension, and Higher Education**

A Report to the  
Secretary of Agriculture



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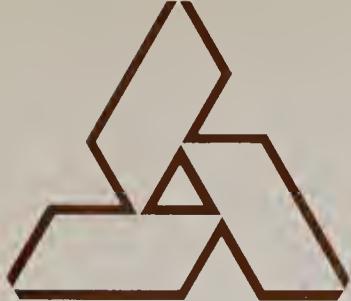
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## Executive Summary

The food and agriculture science and education system uses a wide variety of programs and activities to achieve its goals. This diversity is one of the strengths of the system. Many unique, innovative, and productive programs are underway at the agencies and institutions involved in research, extension, and higher education.

The Joint Council's National Committees—Research, Extension, and Higher Education—submitted more than 280 examples of noteworthy accomplishments achieved in their respective areas during the previous year. For this report, the Joint Council selected examples which are representative of the progress that is occurring in the varied fields and functions that make up the science and education system.

For the second consecutive year, the Joint Council invited a distinguished scientist/educator to prepare an article to be featured in the Accomplishments Report. For this 1986 report, Dr. C. Eugene Allen, Dean of the College of Agriculture at the University of Minnesota, has prepared a paper on challenges to science and education which stem from international relations, trade, and policy.

### Perspectives for U.S. Agricultural Science and Education in a Global Setting

The business of farming in the United States is no longer determined solely by local or national factors. It also is profoundly affected by international events and policies. As the factors that influence agriculture have become more global in character, the scientific and educational dimensions that support U.S. agriculture and agribusiness also must reflect this broader dimension. The ability of U.S. agriculture and agribusiness to address domestic and international challenges and opportunities is dependent upon how they address needs for human and other resources, institutional structures and programs, and the variety of policies affecting agriculture.

Science and education should develop a broad educational initiative addressing the significance of agriculture to the United States and to the world. Information about agriculture should be integrated into primary and secondary school instructional programs. If the number of well-qualified students enrolling in agriculturally related university programs is to be increased, prospective students must be made aware of the range of opportunities associated with careers related to food and agriculture.

The productivity of U.S. agriculture can be related to the teaching, research, and extension programs that have nurtured it. These programs have had a long history of accomplishment, but science and education must continually examine possible improvements. Numerous questions can be raised on how best to organize research, extension, and formal education programs. The competitiveness of U.S. agriculture will be determined in part by the ability of this country to provide suitable and effective answers to these questions. The programs and institutions associated with agricultural science and education must adapt to meet this challenge, and the support for these programs must be commensurate with the real need.

### Cooperative Activities

In numerous instances, two or more States, institutions, agencies, or functions (teaching, research, extension) cooperate in well-planned programs to achieve goals and objectives which have substantial impact on food and agriculture. In the past year, the following cooperative activities contributed significantly to the progress of science and education in food and agriculture.

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- Intensive financial counseling was provided to many financially distressed farm families. In many cases, private and governmental agricultural professionals and lending agencies cooperated in providing information and guidance.
  - A concerted cooperative effort involving several States and Federal agencies is underway to improve water quality in the Chesapeake Bay.
  - Cooperative research has provided information about environmental factors causing acid deposition and about the effect of atmospheric deposition on natural ecosystems.

**Professional Expertise Development**

In each of the past 4 years, the Joint Council on Food and Agricultural Sciences has selected the training of students and the development of professional and scientific expertise to be a top national priority. Several institutions and agencies have made significant contributions to training professionals.

- The National Needs Graduate Fellowships Program sponsored by USDA attracted 259 outstanding doctoral fellows.
- "The Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources," developed by a university, is being used nationally in middle and secondary schools and by 4-H leaders.
- Several universities emphasized international dimensions in higher education.

**Natural Resources**

Water quality and management, reduction of soil losses, and enhanced utilization of forest and range resources are consistently mentioned as high-priority items for science and education attention. These and other accomplishments have contributed to progress toward meeting these goals.

- Economists in one State have developed models which show that the adoption of conservation tillage and no-till production would substantially decrease that State's average annual erosion rates.
- Scientists have found safer, more effective ways to dispose of pesticide wastes through ultraviolet irradiation and have identified microorganisms which degrade soil-applied pesticides prematurely.
- A gene transfer method has been developed which permits transfer of genetic information from a common bacterium into loblolly pine, the Nation's most widely planted forest tree.

**Crop Production and Protection**

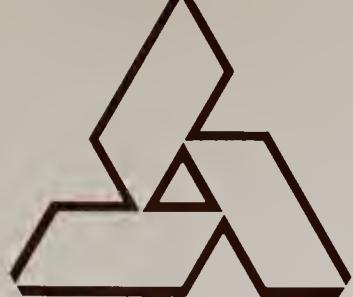
Science and education efforts in biotechnology have increased greatly since it was first identified as an important area for research. Biotechnological processes now finding commercial applications are the result of decades of fundamental research.

- Researchers have developed genetic engineering strategies for grapevine improvement and have obtained a U.S. patent for rapid multiplication of grapevines from single cells.

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- Twenty-five new, disease-resistant, hard red winter wheat varieties have been developed.
  - Scientists have systemically immunized certain plants against diseases by restricted infection with fungi, bacteria, and viruses.
- Animal Production and Protection**
- Production losses due to animal diseases and parasites are a major source of animal production inefficiency. Research and extension programs continue to play an important role in reducing these losses. During the past year, the science and education system has achieved significant progress toward improving animal production efficiency.
- A newly developed vaccine, not yet approved by State or Federal agencies, appears to protect poultry against avian influenza.
  - Grazing lands programs in several States are increasing profitability, protecting soil and water resources, and enhancing wildlife habitats and fisheries.
  - Immunologists have isolated two small molecules that interfere with normal disease-resisting activities against brucellosis in cattle.
- Processing, Marketing, and Distribution**
- Research and education play a key role in improving food quality and safety and in providing linkages between high-grade, wholesome agricultural products and consumption and human nutrition. Likewise, the development of new products to increase markets for agricultural commodities is exceedingly important in today's economy. The following are examples of science and education efforts in these areas:
- Food scientists have found two additives which can replace part of the nitrites used to prevent bacterial growth in cured meats and thus reduce the undesirable nitrosamine formation.
  - A new structural wood panel product, Spaceboard, has been developed. This product is lightweight with great strength and has numerous potential uses.
  - A new cotton ginning process has been developed which will cut energy requirements in ginning by 40 to 50 percent.
- Agricultural Policy**
- Domestic and foreign policy have great impact on agriculture. Accurate knowledge of the agricultural economy and a better understanding of international markets are important components of sound policymaking. The following are examples of accomplishments which contribute the kind of information needed:
- Economists assessed the effects of the tax reform proposals and developed information to ensure that long-term effects on agriculture were considered.
  - Research studies showed that each dollar earned from agricultural exports stimulated another \$1.37 of output in the U.S. economy. These and other studies created more awareness by Federal policymakers of the critical links between general economic policy decisions and the well-being of farmers.

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<b>People and Communities</b>	<p>In nearly every careful assessment of science and education needs, human nutrition and diet and health rank very high. Agricultural profitability and rural revitalization are also of great importance. The accomplishments in this area represent important contributions to these concerns.</p> <ul style="list-style-type: none"><li>• Several research studies were conducted on calcium utilization. One university study showed dietary caffeine increased the loss of calcium from the body. Another study demonstrated that an excessive amount of wheat bran can cause a negative calcium balance.</li><li>• Several programs contributed to the revitalization of rural America. Extension, for example, has developed programs dealing with family and community stress management.</li><li>• A study revealed that former 4-H members are more active in community activities and leadership roles than non-members, and that former 4-H'ers felt their overall experiences more valuable than did participants in other youth organizations.</li></ul>
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## Introduction

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The U.S. Congress established the Joint Council on Food and Agricultural Sciences in 1977. The charge given to the Joint Council was to encourage and coordinate research, extension, and higher education activities in the food and agricultural sciences. The Joint Council is unique among organizations devoted to science and education in that its membership includes not only selected leaders from all of the above science and education functions, State and Federal institutions and agencies, land-grant and other institutions, and certain other governmental agencies, but also industry representatives and agricultural producers.

In 1984, the Joint Council prepared a Needs Assessment Report which presented long-term (20 to 30 years) projections about the needs in food and agriculture and how these needs should be reflected in the activities of science and education institutions and agencies. The Joint Council regularly presents shorter term projections in the biennial Five-Year Plan which is organized under 17 special and subject-matter categories. The Five-Year Plan provides a forum for the continuing evaluation of the goals and objectives of the science and education system. It also provides a standard for evaluating progress, serves as a planning aid for decisionmakers, and provides an accounting of human resource allocations and projections of anticipated changes and needs.

The Joint Council annually develops a list of the most urgent needs of food and agriculture for attention by science and education. These selected priorities are described for each fiscal year in the "Priorities for Research, Extension, and Higher Education." The Priorities Report is used to guide the Federal budget development process related to research, extension, and higher education and is also used by several States to identify the major national problems in which they have a vital interest and to which they can contribute.

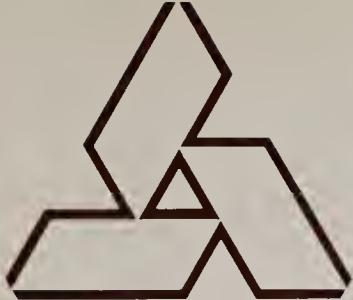
The annual Accomplishments Report offers an opportunity for institutions and agencies to present evidence of their progress in meeting the goals and priorities identified in the various Joint Council reports.

To obtain information for the Accomplishments Report, the National Committees—Research, Extension, and Higher Education—request that examples of the most significant accomplishments of the previous 12 months be submitted to them from each institution and agency that conducts science and education programs. Since each institution or agency is limited in the number of examples it may submit, the National Committees receive reports on a relatively small portion of the total activity underway. Committees choose a representative sample of accomplishments to submit to the Joint Council. The Joint Council, in turn, ultimately selects for the Accomplishments Report only about 20 percent of the examples submitted by the National Committees. Thus the Accomplishments Report describes only a small fraction of the total U.S. science and education activity.

It is clear from studying the accomplishments that the public receives excellent dividends from its investment in science and education. A wide range of problems is being thoroughly studied by the diverse research-extension-education system. There is considerable evidence of planned cooperation among States, among States and agencies, and among the various functions within the system. Such cooperative

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approaches frequently result in more returns per tax dollar expended, and, in many cases, a more rapid solution of problems facing agriculture. The Accomplishments Report, then, provides evidence that the U.S. science and education system is responding to the problems and priorities identified in the Needs Assessment and Priorities Reports and the Five-Year Plan.



## Perspectives for U. S. Agricultural Science and Education in a Global Setting<sup>1</sup>

"My friends, we are no longer just farmers of Morocco, but we are farmers of the world." These were the words of a Moroccan farmer speaking to a small group of other farmers and the United States students who had interned on their farms in 1985. His statement applies not only to production agriculture in the United States and other countries, but also to the scientific, educational, and policy needs associated with the global dimensions of producing, processing, marketing, and distributing food and fiber products. The Moroccan farmer was acknowledging that the business of farming is no longer determined primarily by local or national factors, but by international events and the policies of other countries. Likewise, as the factors that influence agriculture have become more global in character, the scientific and educational dimensions that support U. S. agriculture and agribusiness also must reflect this broader dimension.

The ability of U. S. agriculture and agribusiness to address domestic and international challenges and opportunities is dependent upon how appropriately we address needs related to human and other resources, institutional structures and programs, and the range of policies that affect agriculture and agribusiness.

### Human Needs

U. S. agricultural research, education, and extension programs have a distinguished history of addressing the needs of people. The continuation of this role, however, will require a careful examination of the challenges, opportunities, and limitations that can be identified and addressed.

Everyone depends on food for survival. In addition, about 20 percent of the Nation's work force derive their living directly or indirectly from agriculture. Despite these facts, however, many people in the United States take food and agriculture for granted. This indifference weakens the Nation's ability to appropriately address not only food and fiber issues, but also other issues where agriculture plays an important role. A broad educational initiative in this regard seems justified. One successful approach that needs to be expanded is "Agriculture in the Classroom," where various dimensions of agriculture and related issues are integrated into primary or secondary educational programs. Focus on agriculturally related issues should go beyond the vocational agriculture programs present in many high schools. Issues that relate to soil and water resources, food and nutrition, the application of scientific principles and international trade, for example, are appropriate for the social, biological, and physical science programs of high schools. In the absence of such an educational initiative, there is a serious risk that the United States will be unable to adequately address the variety of challenges and opportunities associated with the broad dimensions of agriculture.

The success of any business, institution, or organization is highly dependent upon the people who are a part of it. Due to the declining numbers of high school graduates and the negative image of agriculture created by the farm crisis, enrollment in many colleges of agriculture has declined in recent years. A 1985 USDA national assessment of employment opportunities for college graduates in the food and agricultural sciences indicates that during the next 5 years there will be a shortfall of about 10

<sup>1</sup>Prepared by Dr. C. Eugene Allen, Dean, College of Agriculture, University of Minnesota, St. Paul, MN 55108.

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percent. Furthermore, this study projects that through 1990 about 75 percent of the openings for agriculture, natural resources, and veterinary medicine graduates will be for scientists, engineers, managers, financial advisors, and marketing, merchandising, and sales representatives.

Significant shortages of college-educated individuals are projected in the scientific and business specialties associated with the U. S. food and agricultural system. In addition, an increasing portion of this demand will be for individuals with advanced degrees and training. Both these projections and the current experience of many employers support the need for more college graduates with appropriate training in the food and agricultural sciences. A serious shortage of appropriately trained people will contribute to weakening the Nation's ability to address domestic and international challenges and opportunities. One way to address this shortage is to gain more visibility for the problem and to make students aware of the range of opportunities associated with careers related to food and agriculture. Although many colleges of agriculture have a significant number of scholarships, there is a need for a large number of prestigious national undergraduate scholarships and graduate fellowships. These scholarships and fellowships would not only attract bright students into these careers, but could serve to highlight the range of career opportunities and staffing needs that exist. There is a great need for this kind of program to strengthen the number and assure the quality of future professionals in agriculture.

## Institutional Perspectives

The productivity of U.S. agriculture can be related to the teaching, research, and extension programs that have nurtured it. These programs have had a long history of accomplishments, which are continuing. However, with the numerous changes that are affecting or will affect agriculture, it is time to examine what might be improved and the alternatives for making those improvements. The following examples have been chosen to raise questions that should be explored.

**Research:** Publicly supported U.S. agricultural research is conducted primarily by scientists in the State Agricultural Experiment Stations, the Agricultural Research Service, Economic Research Service, and Forest Service. Private industry is also actively engaged in research and development programs. Food and agricultural research ranges from basic to applied, from observational to mechanistic to developmental, and from disciplinary to multidisciplinary. The richness of this research and its ability to address problems would be diminished if any of these dimensions were lost or underemphasized. However, it seems appropriate to raise the following questions in relation to needs.

- How can we improve upon the coordination of research in a widely dispersed system and yet address what are sometimes location-specific needs?
- How can we encourage more regional cooperation among institutions and scientists with State, Federal, private, or commodity research support that for the most part is awarded on an annual or a relatively short-term basis?
- How do we encourage more public and private research cooperation, and yet provide the necessary protection for publishing, patenting, and developing new varieties or processes?
- How do we encourage more multidisciplinary research that is oriented toward significant problem areas?

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- What is the proper balance between basic and applied publicly supported agricultural research, and how should it be determined, given the variety of interests and needs that could be addressed?
  - What level of public research support is necessary to ensure that U.S. agriculture remains competitive in relation to the production costs of other countries?
  - How do we develop policies that will encourage investment in research by assuring that cost-effective, environmentally safe, and socially acceptable research can be adapted?
  - How do we assure that major challenges and opportunities are met with timely research that is acceptable to society and that results in the most cost-effective technology? Some examples include the areas of water quality, biotechnology, pesticide resistance, agricultural policy, international trade, minor crops, and alternative agricultural practices.
  - What level of U.S. involvement with international agricultural research efforts will permit U.S. agriculture to both benefit from and contribute to the resolution of world food problems?

These questions and others have no easy answers, but deserve serious attention.

**Education:** People are a major key to the success of any program or organization. Agricultural and other professionals generally need a variety of technical skills combined with interpersonal skills. Feedback from employers often indicates that less than adequate communication and interpersonal skills are a major reason why many college graduates do not achieve their full potential as professionals. There is no reason to believe that agricultural graduates are any different in this regard. Therefore, it seems that the challenge is not only to prepare technically competent graduates, but also to expand graduates' understanding and appreciation in the following areas:

- General communication skills (speaking and writing).
- Interpersonal skills related to teamwork and group dynamics.
- Cultural awareness as it relates to foreign languages and a greater understanding of people from other cultures.
- An expanded understanding of the historical development of the U.S. food and fiber industries and the infrastructure supporting them, coupled with a greater appreciation of the impact of global interactions on past and current developments.
- A greater appreciation of the role of ethics and societal values in technical or economic decisions related to agriculture.

Graduates with this kind of background and appropriate technical skills will be in a much stronger position to address domestic and international agricultural needs.

**Extension:** Much of what has been accomplished through agricultural research in the United States would not have been possible without the close linkage between

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agricultural research and extension programs in the land-grant universities. This need for the transfer of information continues. However, the mechanism for the transfer of at least some of this information is changing in response to new communication technologies, the delivery of some information by commercial firms or private consultants, and the variable needs of different groups. Agricultural extension programs in each State are funded by Federal, State, and county funds and are organized in a variety of models across the country. Since information transfer and lifelong learning among the individuals involved are essential to the competitiveness of U.S. agriculture, the question is not whether there is a need, but how the resources available for extension programs should be used for maximum benefit.

Each State or region should carefully assess the following:

- The priority needs that can best be addressed by extension programs in a State or region.
- The cooperative role between private firms and extension programs that address specific areas of need.
- The use of modern technologies to deliver information whenever satisfactory and possible.
- The ability of and incentives for extension educators to form multidisciplinary teams to solve problems.
- The role of county agents, area agents, and State specialists in extension program formation and delivery.
- An expanded number of State extension specialists with some applied research appointment and responsibility.
- The role of extension in meeting needs in such areas as technology transfer, rural communities, urban programs, rural leadership, youth programs, and agricultural policy assistance.
- The role of extension in bringing food and agricultural issues to the general public and in bringing relevant international issues to producers and professionals in agriculture.
- New initiatives for funding specific extension programs.

The importance of these issues will differ among States, but they represent a variety of challenges and opportunities that can be addressed by extension programs.

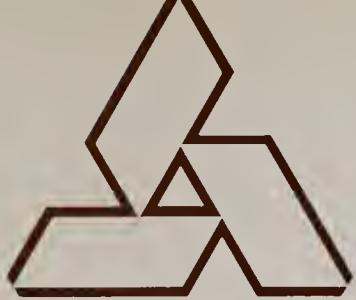
## Conclusions

Agriculture is a major industry in the United States and until recent months has historically contributed to reducing the U.S. balance of payments in world trade. The competitiveness of U. S. agriculture will be determined in part by our ability to develop and utilize new technologies before our competitors do. This ability will be determined by our investment in science and education, our efficiency in transferring new and appropriate technologies, and the policies which relate to agriculture and the

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regulatory, tax, trade, and monetary issues related to agriculture. The loss of world markets, the increasing importation of foreign agricultural products into the United States, a projected shortage of agricultural professionals, and policies that are not market-oriented or that discourage research investments in new agricultural technologies are some of the major reasons for concern about the present and future competitiveness of U.S. agriculture. If these concerns are real and continue over a period of time, U.S. agriculture will suffer a serious setback that will not be corrected in the short term. The programs and institutions associated with agricultural science and education must adapt to meet this challenge, and the support for these programs must be commensurate with the real need.





## Accomplishments of the Food and Agricultural Science and Education System<sup>1,2</sup>

### Cooperative Activities

The science and education system is diverse and complex. Many agencies, organizations, and institutions, State and Federal, public and private, have well-organized programs which contribute significantly to progress. In addition, there are numerous examples where two or more States, institutions, agencies, or functions (teaching, research, extension) cooperate in well-planned programs to achieve goals and objectives which have substantial impact on food and agriculture. A few examples of cooperative efforts are presented in this section.

**Assisting Financially Distressed Farm Families:** Over the past 2 years, the Cooperative Extension system has provided intensive financial counseling to nearly 100,000 farm families. Most States redirected resources to provide intensive educational programs that helped farm families improve their financial management practices. For example, more than 800 farm families in Illinois received confidential financial counseling in a 4-month period. Another 80,000 families received intensive assistance from vocational agriculture teachers; agricultural consultants; and agricultural leaders, including Farmers Home Administration personnel, who were trained by Extension.



In New England, "farm management teams" consisting of Extension specialists, loan officers, and management consultants have worked directly with farm families. Georgia, Montana, and Wisconsin have provided intensive workshops to assist farm families with financial planning. Oklahoma State University economists developed a software package called Integrated Farm Financial Statement (IFFS). This package consists of net worth, cash flow, and income statements and a debt worksheet. IFFS has been used in research, to analyze financial options available to farmers; in teaching, to develop class examples for a course in agricultural finance; and by Extension specialists, bankers, area farm management agents, and financial analysts working directly with farmers and ranchers.

<sup>1</sup>Identification of a State in connection with a research accomplishment indicates that scientists at that State's Agricultural Experiment Station were responsible for the project, unless otherwise specified.

<sup>2</sup>Identification of a State in connection with an extension accomplishment indicates that Cooperative Extension Service personnel in that State were principally responsible for the project, unless otherwise specified. The words "Extension" and "Cooperative Extension" refer to the Cooperative Extension Service.



Residue avoidance program enhances food safety.

Personal accounts from assisted families in nearly every State indicate that the programs helped them assess their financial condition, handle stress, and formulate financial plans to continue the farm business and/or pursue off-farm alternatives to increase profitability and net income.

**Residue Avoidance in Food Animals:** In response to public concern for food safety, the Extension Service operates the Residue Avoidance Program (RAP) in cooperation with the Food Safety and Inspection Service (FSIS), the Food and Drug Administration (FDA), and the livestock and poultry industries. Since the program began in 1978, 49 projects in 33 States have identified problems, developed and disseminated information, improved participation, and developed improved management recommendations. Over 225 educational items have been produced.

A computerized Food Animal Residue Avoidance Databank (FARAD), developed by five cooperating States (North Carolina, Florida, Illinois, California, and Idaho), was the primary source of information following heptachlor contamination of livestock feed in Arkansas, Missouri, and Oklahoma. Voluntary feed sampling helped to identify sources of residues in Iowa, Illinois, Indiana, and Georgia. Demonstration of the Live Animal Swab Test (LAST) in Texas, Oklahoma, Kansas, Georgia, Massachusetts, and other States was useful in keeping animals with residues off the market. Producer organizations are actively promoting voluntary quality assurance programs to certify residue-safe animal products. Statistics compiled by FSIS show that residue violations have been reduced by 81 percent since 1978. The reduction in violations improves the image of the meat supply, protects opportunities for marketing of animal products in foreign countries, increases Government efficiency, and reduces costs.

**Chesapeake Bay Project:** The Cooperative Extension system is playing a major role in developing and conducting educational programs to protect and improve water quality in the Chesapeake Bay. Extension Services in New York, Pennsylvania, Maryland, Delaware, West Virginia, and Virginia have contributed both funding and expertise to the Chesapeake Bay Project. Other team members include the Soil Conservation Service, the Agricultural Stabilization and Conservation Service, and State Departments of Agriculture, along with Soil and Water Conservation Districts.

During 1986, the Pennsylvania Cooperative Extension Service is conducting water clinics concerning how to take samples, how to read and interpret results, and what steps to take to reduce nutrient contamination of ground water.

Maryland Cooperative Extension programs have emphasized surface water quality. In two programs the major thrust is on nutrient management—ways to keep nutrients on the land and out of the bay. Working with the Environmental Protection Agency and the Maryland Agricultural Experiment Station, Maryland is evaluating the effectiveness and economics of Best Management Practices (BMP's). A demonstration farm on the Eastern Shore shows farmers how these different systems work.

**Atmospheric Deposition Research:** The Forest Service atmospheric deposition research program is designed to determine how atmospheric deposition affects forest resources and how it interacts with natural ecosystems. This information is essential for establishing appropriate policies concerning the regulation of emissions of air pollutants. Research is coordinated with that of other agencies participating in the National Acid Precipitation Assessment Program (NAPAP).



Educational programs protect and improve water quality in Chesapeake Bay.



Cloud water collect used to measure atmospheric deposition.

In 1985, Forest Service researchers working in cooperation with scientists from other Federal agencies, the State of New Hampshire, Carey Arboretum, Plymouth State College, the University of Minnesota, and Cornell University, found that a variety of natural and human-caused disturbances—such as beavers, fires, and dams—affect the acidity of some New England ponds.

Working in collaboration with scientists at the University of Georgia and the National Science Foundation, they also determined that sulfate concentrations are increasing in stream water in the southern Appalachians—a signal of the beginning of the watershed's delayed response to atmospheric deposition.

Additional research, conducted in collaboration with North Carolina State University, the University of Pennsylvania, the University of Vermont, and the Boyce-Thompson Institute, determined that atmospheric deposition is one of several factors that may be interacting to cause an observed reduction in growth of red spruce in the Northeast and of several species of pine in the Southeast.

**Boll Weevil Eradication Program:** Economic Research Service economists evaluated the economic impacts of the Boll Weevil Eradication Program conducted on 40,000 acres of cotton in North Carolina. Research technology (including extensive trapping) developed by the Agricultural Research Service and transferred to the Animal and Plant Health Inspection Service was used to reduce cotton insect control expenditures from an average of \$51 per acre to an average of \$17 per acre. The success of the 40,000-acre pilot test led to the expansion of the program to include all of North Carolina and South Carolina. Made possible by the participation of producers through the Southeastern Boll Weevil Eradication Foundation, the expanded effort involved cooperation of the National Cotton Council, the respective State Departments of Agriculture, the State Agricultural Experiment Stations, and Cooperative Extension Services. The boll weevil was virtually eliminated throughout the Carolinas, saving growers millions of dollars per year. Research for increased efficiency and further economic analysis for the boll weevil eradication program is continuing. If growers in Georgia, Florida, and Alabama approve, eradication efforts may be initiated in these three States soon.

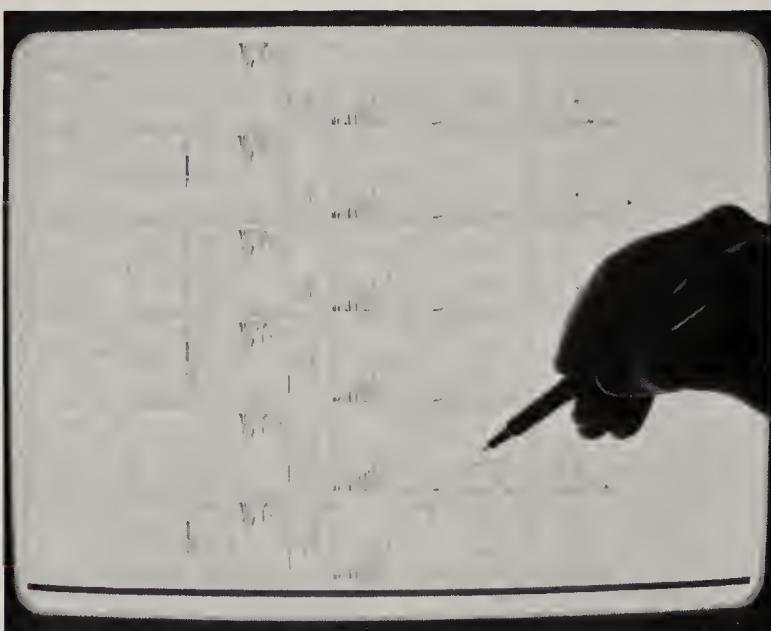


Boll weevil control saves cotton growers millions of dollars.

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**Computer-Aided Management Systems Developed for Cotton Growers:** A team of specialists representing the State Agricultural Experiment Stations and Cooperative Extension Services in Mississippi and South Carolina is conducting preliminary tests of a computer-simulation model (GOSSYM) developed by the Agricultural Research Service to assist cotton farmers in making crop management decisions. The program analyzes a variety of crop and weather information and helps growers make management decisions concerning such things as the proper timing for irrigating and for applying fertilizers and harvest-aid chemicals.

Agricultural Research Service, USDA



Computer expert system helps cotton farmers make management decisions.

This program has demonstrated high potential for assisting farmers in precision and prescription management of cotton crops to reduce unit costs and risks. Economic models and insect control modules are currently being added. A recent survey shows that 22 percent of cotton producers now have computer systems and that another 10 percent intend to acquire them during this year.

**Computerized Expert Systems Network Being Developed To Manage Cornbelt Agricultural Production System:** A multistate, multiagency research venture aimed at improving production practices involves coordinated State, Federal, and private industry efforts. The project is titled by the acronym EXTRA (Expert System for Technology and Resource Conservation in Agriculture). It involves Agricultural Experiment Stations and Cooperative Extension Services from Illinois, Indiana, Iowa, Missouri, Ohio, Pennsylvania, Kansas, Michigan, Minnesota, and Texas. Federal agencies represented are Agricultural Research Service, Cooperative State Research Service, Extension Service, Economic Research Service, Soil Conservation Service, Agricultural Stabilization and Conservation Service, and the Bureau of Reclamation of the Department of the Interior. These cooperators are developing a computerized network of expert systems to help farmers use their own personal computers in making decisions that will result in more profit and more sustainable production systems. The network will help farm operators manage such inputs as nutrients, water, herbicides, pesticides, tillage, and crop varieties. Increased profits and reduced risk to the environment are the objectives of these systems.

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**Soil and Water Conservation:** More than one-third of the Nation's cropland acres are eroding at double the rate which would permit long-term crop production. This problem is aggravated by the inability of many farmers to finance structural practices for reducing erosion. Through articles, reports, tours, demonstrations, and use of computers, Cooperative Extension delivers soil and water conservation programs to a target audience estimated to include over three million people. The information given is based on the results of research conducted at State Agricultural Experiment Stations and at Agricultural Research Service locations throughout the Nation. These programs are designed to complement the technical and financial assistance programs of the Soil Conservation Service and the Agricultural Stabilization and Conservation Service respectively, and are especially important in view of the conservation provisions of the 1985 Food Security Act.

A prime example is STEEP (Solutions to Environmental and Economic Problems). This cooperative effort in Idaho, Washington, and Oregon involving Cooperative Extension, USDA's Agricultural Research Service, State Agricultural Experiment Stations, and the Soil Conservation Service, is targeted on environmental and economic issues in a highly productive but erodible area. In addition, reduced tillage programs such as those in Kentucky and Ohio have demonstrated the importance of conservation tillage.

**Model To Predict Water and Sediment Yields From Rural Basins Validated:** SWRRB (Simulator for Water Resources in Rural Basins), a model developed to predict the impact of alternative management decisions on water and sediment yields, has been validated. In cooperation with the Soil Conservation Service and Texas A&M, the Agricultural Research Service participated in experiments on 11 large watersheds in eight locations across the Nation. The studies showed that the model can realistically simulate water and sediment yields for a wide range of soils, climates, land uses, topographies, and management alternatives. The validation will give consultants, Government agencies, and others who are currently using the model greater confidence in the results they obtain.

**New, Potentially Dangerous Parasite of Sheep Identified for First Time in North America:** Internal parasites cause major economic losses to the livestock industries. The parasite *Nematodirus battus* was recovered recently from the small intestine of sheep born and raised in the Willamette Valley of western Oregon. This nematode previously was believed to have a geographic distribution limited to the British Isles and a small area of Europe, where it is recognized as a significant pathogen in lambs. Information useful for identifying the nematode has been provided, and the Animal and Plant Health Inspection Service, Agricultural Research Services, and State scientists are investigating the potential threat to the sheep industry.

**Professional Expertise Development**

In each of the past 4 years, the Joint Council on Food and Agricultural Sciences has selected the training of students and the development of professional and scientific expertise to be a top national priority. The fiscal year 1987 Priorities Report (prepared in 1985) states: "There is a critical need to attract outstanding students and to enhance the ability of institutions of higher education to produce highly qualified graduates." The Five-Year Plan states: "The shortage of highly qualified scientists and professionals and the increasing difficulties colleges of agriculture are experiencing in their efforts to maintain quality programs represent a significant threat to this Nation's strategic position as world leader in agriculture." The accomplishments listed in this section



Fellowship program attracts outstanding students to study food and agricultural problems.

represent significant contributions by several institutions and agencies to training the scientists and professionals of the future.

**National Needs Graduate Fellowships Program:** The National Needs Graduate Fellowships Program is addressing the human capital shortages facing U.S. agriculture. The program, funded initially in 1984, has attracted some 259 outstanding doctoral fellows. These young men and women represent some of the brightest minds available in the United States today. The average Graduate Record Exam scores for the fellows in biotechnology, agricultural engineering, food science and human nutrition, and agricultural marketing are about 450 points higher than the average scores of all graduate students in agriculture. Dissertation topics chosen by fellows include studies in molecular biology, plant biotechnology, animal diseases, water management, soil erosion, nutritional sciences, and computer applications. The quality of the scientific expertise that will emerge from this program promises to be outstanding.



Laboratory demonstrations help teachers illustrate basic science principles.

**The Science Workbook:** Faculty at Ohio State University identified 53 problems in food, agriculture, and natural resources which can be used as demonstrations in the laboratory or classroom to help teachers illustrate the practical application of basic science principles. These were incorporated into "The Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources." The Workbook also can serve as a source of ideas for student research projects for independent investigations or for district or local science fairs. The projects vary in level of difficulty to accommodate both the gifted and average student.

Copies have been distributed nationally to approximately 20,000 middle and secondary teachers and students, 4-H program leaders, and coordinators of science teaching, and to schools participating in "Agriculture in the Classroom."

**Agriculture and Natural Resource Science Knowledge Transfer to Youth:** In 1985, 4-H youth were enrolled in 4.4 million projects that deal with knowledge transfer in the agricultural and natural sciences. These projects, offered throughout the United States, represent over one-half of the total 4-H project enrollment. The knowledge transferred by the animal/dairy/poultry sciences projects covers both basic information and successful production and management principles. Botanical and agronomic principles of agricultural production and marketing are the bases of the plant science projects.



4-H programs strengthened through addition of modules in science.

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The 4-H programs are strengthened through the addition of modules on science, including biotechnology, genetics, nutrition and food science, and aquaculture. In addition to building expertise in these areas, the lessons expand the image of agriculture and stimulate interest in the study of agricultural science and related careers.

Through on-campus "Discovery Day Programs" 4-H youth receive in-depth exposure to agricultural science research results. Several hundred youth participate in these events each year in Kansas, Michigan, and Indiana.

**Minority Recruitment:** To increase the number of minority students in agriculture and natural resources, several colleges have developed minority recruitment programs.

At Michigan State University, the Minority Apprenticeship Program (MAP) brings junior and senior high school minority students to campus for 7 weeks. The students work 40 hours a week in pre-professional positions for professors or with the Michigan Department of Agriculture or Department of Natural Resources. The students also attend leadership seminars presented by corporate executives. As a result, a significant number of 1985 MAP participants enrolled in the College of Agriculture and Natural Resources.

The Pennsylvania State University has developed the Agricultural Institute for Minority Students (AIMS). This weeklong experience for minority high school sophomores and juniors is designed to introduce students to the advances in science and high technology in agriculture and natural resources. Students live in residence halls and participate in a variety of tours, career seminars, and social activities designed to teach them more about agricultural science. Oregon has used 4-H projects to encourage young native Americans to consider career options in agriculture and natural resources. Qualified young people and their parents or grandparents can participate in a special series of "hands-on" projects.



California Polytechnic State University

Minority students encouraged to enroll in colleges of agriculture.



Resident instruction programs strengthened in 1890 universities.

**Higher Education Strengthening Grants:** This national program was initiated by USDA in fiscal year 1985 to strengthen resident instruction programs in 1890 colleges and universities, Tuskegee University, and the University of the District of Columbia. Approximately \$107,000 was made available to each eligible institution. Projects were required to target one of five specific areas: curriculum development, faculty development, library resources, instructional equipment, or student recruitment and retention. Sixteen institutions elected to use funds for projects focusing on recruiting and retaining students, with special emphasis on competencies and skills deemed essential for success as food and agricultural professionals.

Specific activities funded by these institutions included: enrichment/awareness programs in agriculture for current or potential students; development and distribution of promotional materials; and faculty participation in workshops, symposia, and local, regional, and national meetings focusing on career information and employment opportunities. Two institutions used funds to purchase laboratory equipment which could be centrally located and shared among departments for overall instructional program enhancement.

**National Agriculture and Natural Resources Curriculum Project:** USDA's Higher Education Programs office has coordinated a major national effort to establish a national project which focuses on the development, review, and revision of instructional materials designed to integrate "systems" theory and practices in courses and course modules across the United States. A task force of systems experts representing a number of universities developed instructional materials which were subsequently reviewed by representatives from numerous other institutions. Funding for the project was provided by industry, USDA, and universities in a cooperative effort.

Two workshops at Colorado State University in 1986, one for faculty and one for administrators, helped familiarize them with potential mechanisms, approaches, and materials for effectively integrating systems theory and practices into curricula.

This project is a three-way partnership in which industry, USDA, and universities cooperate to identify curricular needs, establish priorities, develop materials, and disseminate the information to individual faculty who will instruct the future professionals supporting the food and agriculture industry.



University of Florida

Instructional materials developed to integrate "systems" theory and practices.

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**International Dimensions in Higher Education:** The international dimension is receiving increased attention in undergraduate programs of study at several colleges of agriculture.

The University of Illinois has prepared a directory of all its courses which have an international orientation, including a new course on "Spanish for Agriculturalists," and a directory of companies offering possible employment opportunities in an international setting.

The Pennsylvania State University has designed a minor in international agriculture to enable students to gain an awareness and appreciation for the interrelationships and interdependency of the nations of the world for their food and fiber as well as an understanding of technical transfer across cultures.

The College of Natural Resources at the University of Wisconsin at Stevens Point has developed a summer program on International Environmental Resource Management in West Germany, Poland, and Costa Rica.

California Polytechnic State University



Courses offered to increase student awareness of international aspects of agriculture.

**Politics, Ethics, and Social Issues in the Food and Agricultural Sciences:** Those involved in the food and agricultural sciences are frequently faced with the philosophical and ethical dimensions of production, processing, and distribution practices and policies.

The College of Agriculture of the Institute of Food and Agricultural Sciences at the University of Florida has established a program in "Philosophical Studies in Agriculture and Natural Resources." As part of this program a senior-level course entitled "Politics and Ethics in Agriculture" has been developed to survey issues concerning the structure of American agriculture; technologies in production of food and fiber; food and feed distribution issues; and the role of public agricultural research.

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The College of Agriculture and Life Sciences at the University of Vermont has initiated a freshman program called "Ethics, Morals, and Careers." This program focuses on ethical issues related to potential career fields and provides the student the opportunity to participate in public forums on a few selected topics.

## Natural Resources

Soil, water, and air are fundamental to the production of food, fiber, and forest products as well as fish and wildlife habitat. The 1986 Five-Year Plan emphasizes the importance of soil conservation and the preservation of water and air quality. In the 1987 Priorities Report, a high priority was placed on increased science and education efforts on water quality and management. Several accomplishments in this area are included in the "Cooperative Activities" section of this Accomplishments Report. The accomplishments described below emphasize the importance of enhanced utilization of our forest resources, reduction of soil losses, and the retention of a high-quality water supply.

**Wood Utilization:** A new method for processing pulpwood that may reduce paper mill energy and production costs by 80 percent or more, cause virtually no air or water pollution, and double pulp yields has been developed at the University of Wisconsin.

A combination of water, acetic acid, and ethyl acetate creates a remarkable solvent for dissolving lignin—the glue that holds wood fibers together.

The method, called ester pulping, not only recycles the chemicals that separate wood fibers, but also produces more of the chemicals needed to process pulp. These innovations dramatically reduce operating costs and pollution.

Plywood and particle board are currently made with adhesives derived from oil and gas. The work in Wisconsin provides a new way to glue these wood products with a tree's natural glue, lignin. Chemically modified lignin applied to wood treated with sodium hydroxide creates a bond as good as those made with oil-based glues.

**Transfer of Genes From Bacteria Into Pines:** Biotechnology applied to forest trees is rapidly coming closer to reality. The methods of gene splicing that promise to bring new products in medicine, industrial biochemistry, and agricultural crops also have significant potential in forestry.

A method for gene transfer has been developed by scientists of the Forest Service's Pacific Southwest Station, North Carolina State University, and Oregon State University. They have succeeded in the transfer of genetic information from a common bacterium into loblolly pine, the Nation's most widely planted forest tree. This is the first demonstration of gene transfer and function in a commercially important conifer. This result makes it possible for genes derived from other plants or created in the laboratory to be transferred into commercial tree species. The long-term goal of these studies is genetic improvement of trees without the limitations of long breeding cycles.

**Legal Education on Pesticide Use and Impact Assessment:** Agriculture functions in an increasingly complex mass of laws and regulations pertaining to pesticides. Project materials developed by the Extension Service have proven instrumental in providing agricultural interests and the Environmental Protection Agency with the information necessary to make knowledgeable judgments in the special pesticide review process.



Improved procedure developed for making plywood and particle board.



Microbes carry novel genes into conifer cells.



Extension holds workshops on safe and judicious use of pesticides.

Through Cooperative Extension education, agricultural communities are now aware of the legal necessity for installing irrigation backflow prevention equipment. This has dramatically reduced the potential for ground-water contamination. Over 60 workshops and seminars detailing regulatory policy and legal incentives for the safe and judicious use of pesticides have, on request, been presented to some 12,000 farmers, ranchers, Extension personnel, researchers, and agricultural trade association members in 45 States.

**Environmental Fate of Pesticides:** There is increasing evidence that soil microorganisms can destroy soil-applied pesticides before the target pest has been controlled, and also that they have potential in the disposal of pesticide wastes. Agricultural Research Service (ARS) scientists isolated an active soil bacterium that can destroy carbofuran in a matter of hours. Because carbofuran is one of the major soil-applied insecticides, this breakthrough should lead to more efficient pesticide use.

A major problem of farmers and commercial pesticide applicators is the safe and effective disposal of pesticide wastes. ARS scientists have developed a new approach to pesticide waste disposal involving the use of ultraviolet irradiation and ozone to break up the pesticide molecule so that it can be metabolized easily by microorganisms isolated from the soil. This new disposal technology has been tested successfully on several widely used pesticides.

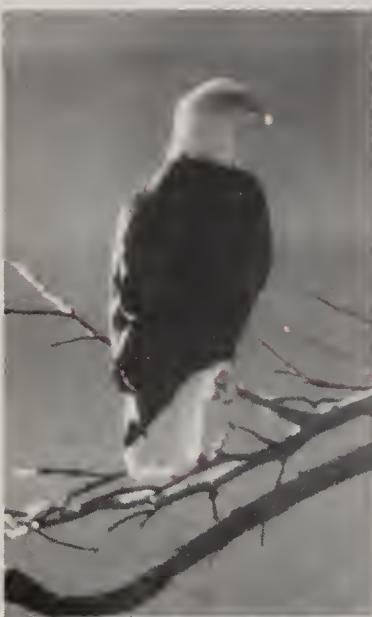
**Erosion Potential and Economic Impact of Alternative Tillage Systems:** Agricultural economists in Ohio used a seven-region model to simulate the soil erosion changes and economic impacts that would result from the use of alternative tillage systems. Results demonstrate that regional impacts would be significantly different across the State.

Statewide adoption of conservation tillage and no-till production would decrease Ohio's average annual erosion rates to a level nearly 15 percent below the maximum permissible soil loss per acre per year.

In eastern and southeastern Ohio, where erosion rates are among the highest in the State, soil losses would be greatly reduced but would still be in excess of soil loss



Destruction of pesticides by soil microorganisms studied.



Characteristics of winter bald eagle roost sites identified.

tolerance values on many farms. Crop yields would increase moderately, but where costs of pesticide application increase significantly there would be a slight decrease in net returns.

**Threatened, Endangered, and Sensitive Wildlife and Fish:** Some 180 wildlife and fish species in the United States are listed as actually or potentially in danger of extinction. Forty-seven of these species occur, or potentially occur, in National Forests. Forest Service researchers have studied habitat requirements of over 20 threatened and endangered species. Research completed includes: (1) development of the "Red-Cockaded Woodpecker Recovery Plan," which provides a Federal management strategy; (2) development of information on factors limiting Kirtland's warbler populations on their breeding grounds; (3) a symposium on the northern spotted owl, which synthesized all known information on this species; and (4) identification of the characteristics of winter roost sites of bald eagles in northern New Mexico.

**Enhancing Agricultural Profitability Through Fish and Wildlife Management:** Hunters, fishermen, and other recreationists spent more than \$41 billion in 1980. More than two-thirds of these activities took place on private lands and waters. Fees charged for wildlife-associated recreational opportunities on private agricultural, range, and forest land can provide owners and managers with income-generating opportunities.

Extension Service wildlife and fisheries programs provide landowners and managers with the skills to implement management practices and to market increased recreation opportunities on their land without diminishing the profitability of other uses. In Texas, an Extension 19-county pilot project helped ranchers increase annual income from hunting and fishing leases by over \$7 million. Other Extension programs in Mississippi, Louisiana, Tennessee, New Mexico, Michigan, Colorado, and South Carolina helped increase income to participating farmers and ranchers by an estimated \$21 million in 1980.

## Crop Production and Protection

The emergence of modern biotechnology has excited the imagination of scientists and entrepreneurs alike. The Joint Council has given biotechnology a very high priority rating in several recent priorities reports. Through biotechnology, plants, animals, and microbes can be modified to enhance their benefits to society. The 1986 Five-Year Plan emphasizes the importance of improved efficiency in field crop and fruit production and states: "The need to optimize crop production while conserving the resource base has never been greater." One of the Five-Year Plan goals is to maintain economical and efficient pest control methods that are consistent with the maintenance of environmental quality. The accomplishments listed in this section provide evidence that the science and education system is conducting an aggressive attack on significant problems in crop production.

**Plant Immunization:** Working with green bean, tobacco, cucumber, watermelon, and muskmelon, scientists in Kentucky demonstrated that restricted infection with fungi, bacteria, and viruses can systemically immunize plants against diseases caused by those organisms. Immunization protected cucumber, watermelon, muskmelon, and tobacco throughout the season, and a single immunization protected cucumber against at least three unrelated diseases.



Inoculated cucumber plant (right) protected against cucumber scab fungus.

The signal for immunization in cucurbits, (e.g. cucumbers, melons, and squash) and tobacco is graft-transmissible from rootstock to scion. The persistence of immunization and data from girdling experiments give further evidence of the production of a chemical signal at the site of induction.

Resistance to blue mold in tobacco has been transferred from immunized parents to regenerants via tissue culture, and regenerants were resistant in greenhouse and field tests.

**Using Selective Pesticides:** The action of natural enemies in citrus agro-ecosystems is crucial to the effective management of many pest insects which affect citrus yield and quality. Application of pesticides to combat pests often disrupts the natural enemies.

Research conducted in California identified pesticides which are selective in their action against the three most serious insect pests of citrus. When used against citrus thrips, one pesticide was nearly harmless to three beneficial species; two others were toxic, with residues lasting 15 to 25 days; and a fourth was toxic for 40 days.

The results of this research make possible the selection of pesticides which will have the least harmful impact on desirable natural enemies, thus increasing the ability of those natural enemies to continue controlling pests.



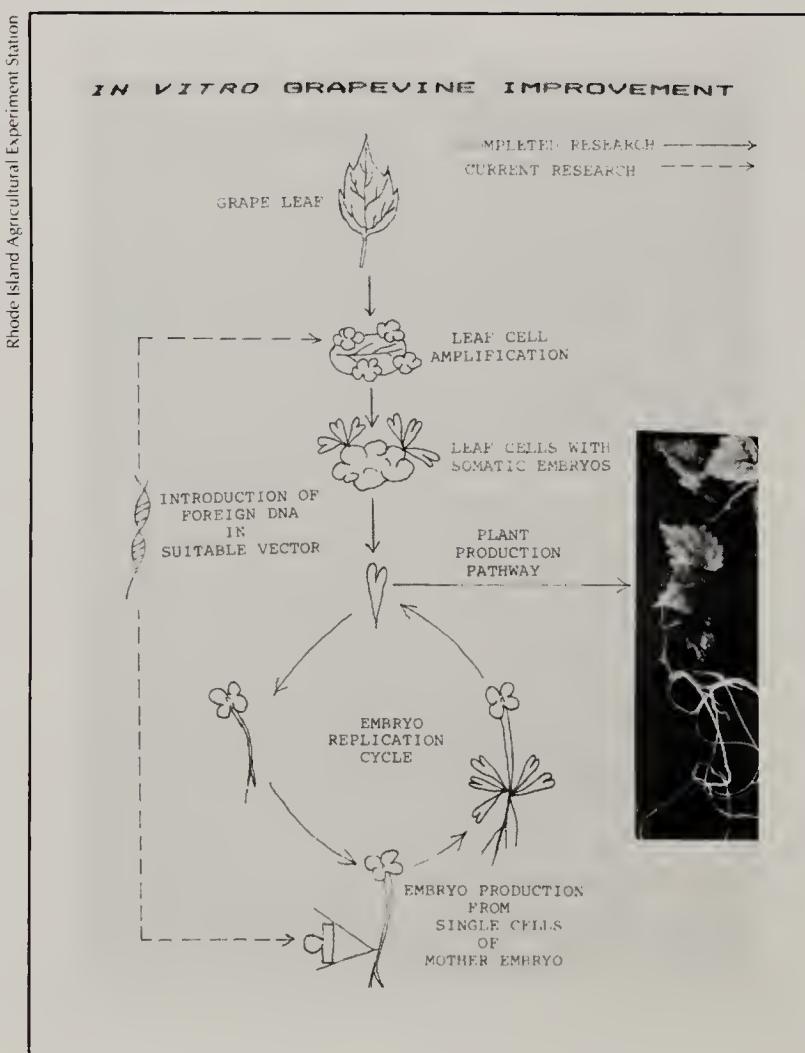
Pesticide effects on harmful and beneficial insects studied.

**Monitoring Genetically Engineered Bacteria in the Environment:** Studies at the University of California on the regulation of *Agrobacterium*, a bacteria causing crown gall in plants, required the development of a direct method for following the expression of the genes while the bacterial cells interacted with plant cells. The researchers isolated a sequence of genes that code for the synthesis of a light-releasing enzyme, luciferase. They reconstructed this gene so that it was functionally expressed and inserted it into a vector which was then reinserted into *Agrobacterium*. The monitoring of plant pathogen interactions and the expression of gene virulence was accomplished by observing the release of light.

**Impact of Plant Biotechnologies on Plant Breeding and Agriculture:** With the recent development of new plant biotechnologies, the range of research approaches open to plant scientists has increased significantly. A Kentucky project, with support from the

Ethics and Values in Science Technology program of the National Science Foundation, has examined the potential impacts of the new plant biotechnologies on both plant breeding and agriculture. Among the key findings are: (1) Most current biotechnology research is oriented toward developing a plant material that is herbicide-tolerant. (2) The number of public-sector plant breeders, particularly breeders of minor crops, has declined significantly. (3) The ability of the public sector to train plant breeders for both the public and private sector has been somewhat weakened. (4) Given the expense of biotechnology research, not every State will be able to afford to mount a full-scale program. This could adversely affect the agriculture of the States with weaker programs. (5) Farmers may be phased out of their roles as the primary clients for public plant-breeding research as agribusiness companies take on more applied work. By making policymakers and research administrators aware of these issues, this research is helping to ensure that the new biotechnologies have a positive and equitable effect on agriculture.

**Multiplication of Grapevines:** Improvement of crop plants that are noted for clonal quality characteristics is dependent upon nontraditional breeding methods such as selection of clonal variants or genetic engineering.



Methods for grapevine improvement by genetic engineering strategies developed.

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Researchers in Rhode Island developed methods for grapevine improvement by genetic engineering strategies and have obtained a U.S. patent for rapid multiplication of grapevines from single cells. This method solves two of the problems of vine improvement via genetic engineering strategies—it provides a single-cell system for the acceptance of foreign genes, and it provides a method for rapid multiplication of vines from cells, once transformed. More than 1 trillion vines can be produced from a single cell within a year.

**Genetic Basis of Pathogenicity:** The *Erwinia carotovora* plant soft-rot system is related to the well-studied enterobacteria, which are animal pathogens. The soft-rotting bacteria cause economically important diseases that are not well controlled by chemical means. Basic studies of their pathology on plants may yield new information important to control. Scientists from Virginia and Massachusetts, using molecular biological techniques, have cloned many of the genes that code for these enzymes. This molecular approach will allow observation of variation in a single gene and a single enzyme at a time, which will permit, for the first time, the precise determination of the roles these enzymes play in pathogenesis. Such knowledge may suggest new control measures for soft rot disease.

**Econo-Rice Reduces Production Costs:** A new era of rice production for the Southern United States was ushered in with the development by Texas scientists of "Lemont"—a lodging-resistant, semidwarf, long-grain rice variety with a tailored production package designed to achieve maximum economic productivity. Average yields increased 30 percent while production costs fell 28 percent between 1983 and 1985. New varieties increased from 1 percent to 80 percent of the rice acreage during this period. Fields of Lemont in Texas were hit by hurricane Alicia at harvest time in 1983; hurricanes Danny and Juan hit Louisiana Lemont fields nearing harvest in 1985. These hurricanes caused less than 5 percent lodging, quality, or yield loss in Lemont rice, while other varieties nearing harvest sustained losses of 50 percent or more.

Texas Agricultural Experiment Station



High-yielding, lodging-resistant rice cultivars developed.



Improved disease-resistant wheat varieties improve farm income.

**Disease-Resistant Wheat Varieties:** A 25-year project in wheat breeding at the University of Nebraska resulted in development of 25 new disease-resistant hard red winter wheat varieties that account for 90 percent of the Nebraska wheat acreage, 40 percent of all U.S. hard red wheat acreage, and over 20 percent of all U.S. wheat acreage. These improved varieties contributed at least 23 million additional bushels annually during the period of the project, providing additional annual farm income of \$100 million in Nebraska alone. Because they possess effective resistance to stem rust, the most dangerous wheat disease in Nebraska, together with improved resistance to lodging, these varieties have contributed significantly to the stability of wheat production and of U.S. agriculture. In addition, the germplasm in varieties from the project are prominent parental materials in most hard red winter wheat varieties of the Great Plains.

**Increased Soybean Oil:** Agricultural Research Service scientists have shown that oil is formed by "plastids," which are structures within the cells of soybean seed. This finding is of special importance because it indicates that the mechanism for oil formation in plants is different from that in animals. Finding the location of the enzymes (proteins) that govern oil synthesis enhances the likelihood of increasing soybean oil production through plant breeding.

#### Animal Production and Protection

In spite of the importance of livestock products to the consumer and the importance of livestock enterprises to American agriculture, numerous problems limit further improvements in animal production efficiency. Reproductive inefficiency is a major problem to livestock producers, and improved forage production and utilization are very important. Livestock and poultry producers continually face major and unpredictable risks of substantial losses from diseases, parasites, and health hazards. The Five-Year Plan states: "High priority must be given to optimizing production input costs to efficiently produce quality animal products that are financially appealing to consumers." The seven accomplishments listed herein are typical of the advances made in the area of animal production and protection.

**Grazing Lands Programs:** Extension grazing lands programs are designed to increase profitability and diversification of farms and ranches, protect soil and water resources, and enhance wildlife habitat and fisheries. Twenty States are conducting major programs in grazing land management, and an additional 35 programs in 22 States include grazing land management in livestock, forage, conservation, or other programs. Fifteen States developed software and held computer workshops for grazing land managers. Colorado workshops presented management recommendations for yearling range cattle that produce additional gains of 20 to 30 pounds per animal.

Wildlife habitat has been improved on 1 million acres through a coordinated public/private program involving more than 3,000 participants in Washington. California's computerized Renewable Resource Information System was instrumental in initiating a major new state-funded research and education program directed at hardwood rangeland.

Programs designed to increase profitability and diversification of farms.

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**Young Bulls Produce Lean, Natural-Type Beef:** Scientists in Nevada have devised a unique program to produce the lean, natural-type beef products demanded by consumers. Typically, beef is produced by steers which are treated with hormonal adjuvants or feed additives to stimulate growth and which are raised on concentrated feed diets. They are marketed at 15 to 20 months of age. The Nevada program uses young crossbred bulls, which are slaughtered at 12 months of age after receiving a low-concentrate diet. No growth promotion substances are used. Bulls are much more efficient than steers in converting feed energy to edible tissue, and bull beef is leaner and higher in polyunsaturated fatty acids than steer meat.

Nevada Agricultural Experiment Station



Beef production program uses young, crossbred bulls to produce lean beef.

**Vaccine Protects Poultry Against Avian Influenza:** Pennsylvania researchers have found evidence that an influenza vaccine is effective in protecting poultry against avian influenza. The fatal poultry disease has necessitated the destruction of millions of birds since 1983. The vaccine must be Government approved before it can be released for general use.

In a parallel development, the virus was recovered by Agricultural Research Service scientists from the yolk, albumen, and shell surface of eggs obtained from chicken flocks in Pennsylvania and Virginia. These recoveries provide essential information required to prevent spread of the virus associated with commercial movement of table and hatching eggs.

**Aquaculture Educational Program:** The close linkage of agricultural research and extension educational programs at land-grant universities has played a major role in the recent expansion of the aquaculture industry. Research on fish diseases has enabled Extension specialists in Mississippi to identify and recommend treatment for over 1,700 fish disease cases in 1985, thereby reducing losses and increasing profitability. In Texas and Louisiana, research and extension programs have contributed to a three-fold increase in per-acre production in the crawfish industry. Additionally, Extension programs in Alabama, Arkansas, Georgia, Kentucky, South Carolina, and other States have led to increased awareness of both commercial and recreational aquaculture opportunities among adults and 4-H youth. Enrollment in 4-H marine and aquaculture programs now stands at 30,000 nationwide.



Aquaculture industry assisted by research and extension programs.

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**Reducing Calf Losses and Increasing Calving Ease:** Calf losses were reduced and animals returned to breeding more quickly through the use of a natural hormone in research at Iowa. Relaxin, a hormone produced primarily during pregnancy, is administered to beef heifers 5 days before the end of the normal gestation period. Not a single instance of retained afterbirth has occurred, and the treatments significantly increased calving ease.

Researchers in Maryland have found a way to reduce the risk of "retained fetal membrane" syndrome, a \$15-million-a-year problem for the Nation's dairy industry. They induced calving in expectant heifers with the drug dexamethasone. Within an hour of delivery, the heifers were injected with prostaglandin, a fatty acid compound that occurs naturally in the bodies of cattle and helps regulate reproduction. Only 9 percent of heifers receiving this treatment retained their afterbirth, while 91 percent of the control group did.

Iowa Agricultural Experiment Station



Natural hormone to increase calving ease studied.

**Brucella Involved in Immune System Function Studies:** Iowa immunologists have completed research which may have far-reaching implications in understanding many bacterial diseases. These researchers have isolated two small molecules, guanosine-5'-monophosphate and adenine, which are released by *Brucella abortus*, the bacterium causing brucellosis in cattle. These two molecules interfere with the body's normal disease-resisting activities, allowing the infection to become established. The Iowa scientists are investigating immunologic and pharmacologic methods for overcoming the interference of these molecules with disease resistance. This research may result in novel approaches for treating diseases of man and animals.

Iowa Agricultural Experiment Station



Molecules interfering with disease resistance identified.

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**Ultrasound Can Improve Cattle Breeding Techniques:** Animal breeding and biotechnology can be greatly improved by using high-frequency ultrasound waves, according to Texas animal scientists. Ultrasound research is providing methods to improve artificial insemination and embryo transfer programs, to improve superovulation, and to aid in selecting recipient cows.

Other uses include early pregnancy determination in domestic animals. It is now possible to verify pregnancy as early as 28 days in cattle, 14 days in swine, and 12 days in horses. Use of this equipment is expected to spread fairly quickly, because it greatly improves efficiency and ultimately will cut costs.

#### **Processing, Marketing, and Distribution**

The Five-Year Plan pointed out that food and fiber marketing firms contribute about 75 percent of the value added and employment in the U.S. food system and that the food processing and distribution industries significantly influence both agricultural producers and consumers. The 1987 Priorities Report (prepared in 1985) emphasized the importance of research and education efforts to improve food quality and safety and to provide linkages between high-grade, wholesome agricultural products on one hand and consumption and human nutrition on the other. The accomplishments identified in this report identify new products and processes which will enhance markets for agricultural and forest products.

**Competitiveness of U.S. Agriculture in World Markets:** The Economic Research Service (ERS) began a multi-year study to compare costs of production among major exporting countries and to assess the effects of trade barriers, subsidies, and other policy interventions on those costs. In other trade-related research, ERS analysts found that in the first year after a change in export prices the volume of exports changes less in percentage terms than the opposite change in prices, thus resulting in a *loss* of total revenue from exports when export prices decline. After a 2- to 3-year lag, however, total revenue from exports increases in response to the decline in prices. Such information helps policymakers understand when to expect results from policies aimed at increasing U.S. exports by lowering export prices.

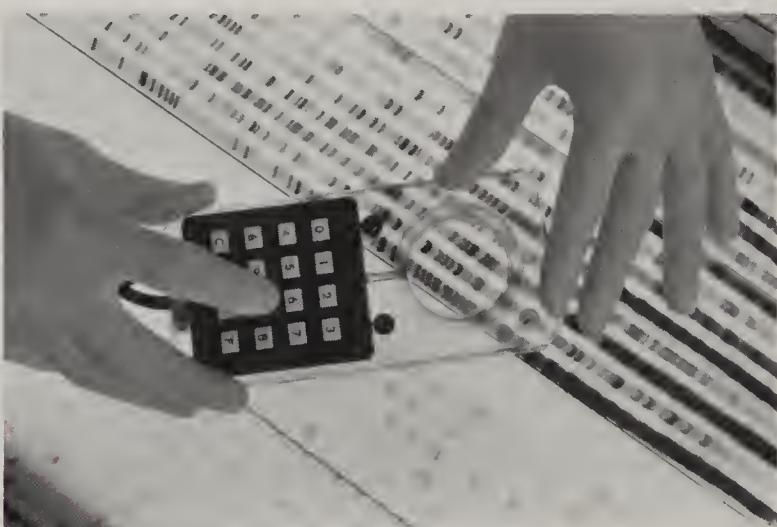
**Spaceboard—New Wood Panel Product:** Research at the Forest Service's Forest Products Laboratory in Madison, Wisconsin, has led to the invention of a new structural panel product. The new material is a "sandwich" of pulp fiber panels that are molded in a wafflilelike configuration directly on the paper-making machine. The name Spaceboard is derived from the light weight and great strength of the new material, which could have structural applications in space. Spaceboard has been made only in small laboratory samples, but work continues on concepts that will allow for continuous production. Potential products from the Spaceboard process include containers, paneling, storage tanks, and mobile homes.

**Fungal Protein Shown To Induce Ethylene Biosynthesis:** A highly purified protein fraction of fungal origin was shown by Agricultural Research Service scientists to induce the biosynthesis of ethylene, a ripener hormone, in many plant tissues. Protein in this fraction interacts at the plasmalemma to produce a factor that activates ACC synthase, an enzyme that controls the rate of ethylene biosynthesis. These findings help explain how ethylene biosynthesis is regulated in higher plants and how ethylene is involved in host-pathogen interactions. The fungal protein, a natural bioregulator, will give producers another tool to control ripening.

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**New Tool To Increase Quality and Value of Soybeans:** A limitation in applying biotechnology to improve the quality of important crops is the difficulty of identifying and isolating genes controlling plant traits. Transposable elements are units of DNA which are capable of changing their positions in the chromosomes of the plant. In soybeans, the complete structure of the DNA element which causes a mutation in the activity of a seed protein gene has been determined by Agricultural Research Service scientists. It resembles transposable elements in corn in several key features. Using the soybean element as a probe may allow investigators to identify genes which control crop traits of importance to the farmer and processor.

Agricultural Research Service, USDA



"Jumping" genes may provide key to genetic engineering of crop plants.

**Calcium Alginate as a Binder of Restructured Meat:** Colorado researchers have developed a raw meat binder which permits the manufacturing of fresh meat into the size, shape, and quality desired by different groups of consumers. Sodium alginate, the water-soluble sodium salt of alginic acid, reacts with calcium ions released upon slow hydrolysis of calcium carbonate. A strong calcium-alginate gel is formed which serves to bind meat pieces together. The gel mechanism produces structured meat products which bind, not only in the cooked state, but also in the raw, refrigerated state. This technology allows structured meat to be marketed to the hotel, restaurant, and institutional industries through existing fresh meat channels.

**New Ginning Process Improves Cotton Fiber Quality and Reduces Costs:** A radically new, simplified ginning and cleaning process has undergone successful pilot evaluation by the Agricultural Research Service. The new design combines a gin stand and two lint cleaners into a single unit and would replace the air transport machinery currently used. The new design should cut the energy required for ginning by 40 to 50 percent; improve quality of the cotton fiber; and reduce space, capital, and operating costs in new gin installations.



Simplified ginning process reduces energy requirements by 40 to 50 percent.

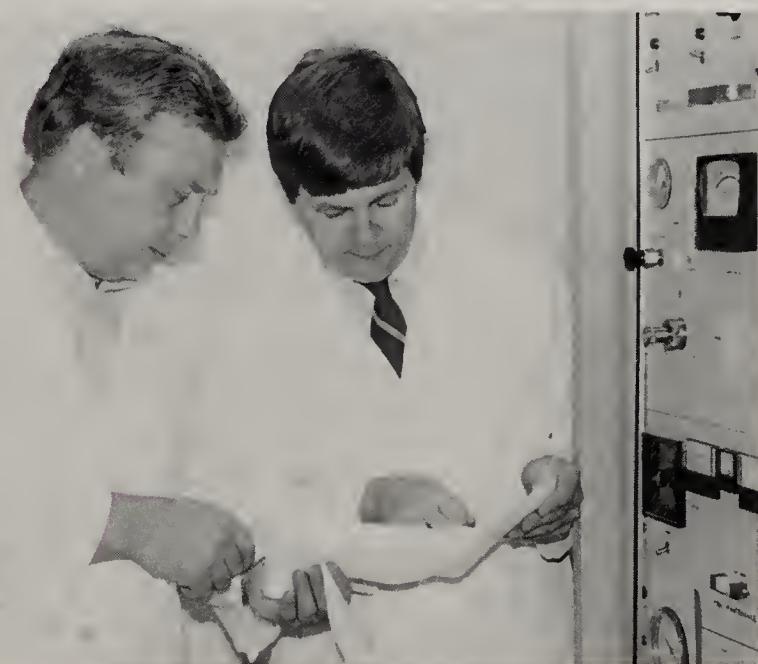


Interdisciplinary research results in development of white muscadine grape juice.

**A New Industry for Mississippi: Muscadine Grapes:** A new agricultural industry has been spawned as the result of interdisciplinary research by scientists at the Mississippi Experiment Station. In the early 1970's, test vineyards were established for evaluation of a number of improved muscadine varieties. Four bronze self-fertile varieties—Carlos, Magnolia, Sterling, and Doreen—have proven to have superior production and processing qualities. Food technologists and enologists made small lots of white muscadine juice for in-house testing for several years. In 1983, consumers in two Memphis supermarkets preferred the white muscadine to another white grape juice by a ratio of 2 to 1. White muscadine juice has been consumer tested in six cities and two Mississippi shopping malls, again with 2 to 1 consumer preference.

**Minimizing N-Nitrosamine Formation in Cured Meats:** There is a widely recognized need to minimize formation of N-nitrosamines in cured meats—an occurrence which results from reaction of nitrites with certain amines or amino acids. Nitrite use cannot be discontinued unless an alternative substance can be found to prevent *Clostridium botulinum* growth in cured meat. Food microbiologists evaluated the nitrite problem and sought alternative solutions. They have found two alternative additives, sodium hypophosphite and potassium sorbate, that inhibit the growth of *c. botulinum* and thus permit the reduction of the nitrite levels in several cured meats. Both alternatives have FDA approval for some purposes but would require additional clearance for the proposed use.

In Michigan, results from pilot studies have clearly demonstrated that salts coated with vitamin E can be applied to both dry-cured and brine-cured bacon to inhibit nitrosamine formation without any changes in current processing procedures. This also has been demonstrated in studies with brine-cured bacon prepared with commercial pumping systems.



Alternative additives permit reduction of nitrites in cured meats.

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## Agricultural Policy

Appropriate policy choices can improve the economic well-being of consumers, farmers, and rural society. Accurate knowledge of the agricultural economy is necessary for intelligent policymaking and is useful for predicting the consequences of policy alternatives. The Five-Year Plan emphasized the importance of a better understanding of international markets and the long-term financial and adjustment needs of small, medium, and large farms. This section of the Accomplishments Report addresses several needs described in the Priorities Report and the Five-Year Plan.

**Tax Reform and the Agricultural Sector:** An Economic Research Service assessment of the effects of the Administration's tax reform proposal was instrumental in ensuring that the long-term effects on agriculture were considered as the tax reform proposals were formulated and modified. Most farmers will be in the new 15-percent tax bracket; their Federal income taxes will be about the same as or less than what they have been paying under the current law. However, some farmers, particularly livestock producers, will pay more taxes. The elimination of the investment tax credit and reform of depreciation allowances will cause an increase in the cost of capital and a decline in overall investment. While the effects of the tax reform on the overall economy will be relatively small, the agricultural sector may benefit from increased disposable income of consumers, which may, in turn, lead to increased expenditures for food. Reduced incentives and opportunities for tax-motivated investments will reduce distortions in relative input and commodity prices that have occurred as a result of the current tax system.

**Agricultural and Trade Policies:** Economic Research Service (ERS) economists evaluated the more significant policies employed by the United States and other major trading countries, including commodity price policies, income policies, and trade policies (such as embargoes, subsidies, credit, and food aid). The costs of domestic and trade policy interventions, as measured by Government expenditures on agriculture, were compared. Much of the support for agriculture, however, is through other means. The European Community (EC) and Japan can raise prices to producers simply by restricting imports. The direct budgetary costs of those interventions may be negligible, but the subsidy can be very large. ERS researchers found, however, that apart from the EC, U.S. competitors are providing relatively little assistance to their producers in the form of direct producer subsidies. These ERS studies have provided U.S. trade negotiators with important information for their use in improving world trade conditions generally and specifically in reducing trade barriers and unfair trade practices.

**Agriculture in an Open Economy:** The Economic Research Service (ERS) found that the linkages between the farm economy and the national economy are so close that conditions beyond the farm gate can affect agriculture as much as farm programs do. Business cycles are now international, and global business cycles affect farmers' production costs, the demand for their products, their competitiveness in domestic and international markets, and, ultimately, their income and wealth. And agriculture can affect the national economy; for example, each dollar earned from agricultural exports stimulates another \$1.37 of output in the U.S. economy. Approximately 80 percent of that additional economic activity accrues to the nonfarm sector, and over 1 million jobs are related to U.S. agricultural exports. By having this ERS-generated information, Federal policymakers and farm leaders are now more keenly aware of the critical links between general economic policy decisions and farmer well-being and are taking those links into account in economic policymaking.

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**Agricultural Policy Education:** In 1986, farmers and ranchers faced more Federal program options than ever before. The Food Security Act of 1985, signed late in 1985, called for farmer decisions in March and April 1986. The Extension system launched an all-out effort to provide information to farmers. Educational materials and decision aids were developed in close cooperation with the Agricultural Stabilization and Conservation Service (ASCS), the Economic Research Service, and the Soil Conservation Service. Virtually every State Cooperative Extension Service provided producers with details of the farm program and supplied them with decision aids, ranging from simple worksheets to comprehensive computer programs. The complexity of the new legislation, delays in administrative decisions, and two technical amendment laws passed well into 1986 made the educational job not only more difficult and time-consuming but also more important. County ASCS offices credited Extension educational efforts with considerable savings in agency and producer time and resources.



Producers provided with details of the farm program.

## People and Communities

This section of the Accomplishments Report is very broad and covers many of the activities of the Cooperative Extension Service as well as human nutrition research. The Joint Council, in its priority-setting activities, has consistently placed human nutrition and diet and health as very high-ranking priorities for science and education programs. The Priorities Report emphasized both the need to deliver research and education programs focused on increasing farm and forest profits and the importance of better integration of management, production, and marketing strategies. The Five-Year Plan stressed the need for improving the education, economic security, and political decisionmaking skills of minorities by innovative programs directed toward minority youth. Human nutrition research achievements, extension nutrition education programs, and activities designed to enhance rural revitalization and youth development are discussed in this section.

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**Human Nutrition, Diet, and Health:** Public interest in human nutrition, diet, and health in recent years has been overwhelming. The food and agricultural sciences system has been challenged to provide the research and educational programs necessary for improving the diets and health of the people.

Research has provided some breakthroughs in human nutrition. An Agricultural Research Service (ARS) study showed that women with the lowest dietary calcium intake experienced significantly more bone mineral loss. Researchers in Washington found that dietary caffeine increases the loss of calcium from the body and increases the need for dietary calcium to maintain optimum bone health and blood pressure. Another ARS study demonstrated that wheat bran acted as a mineral sink to remove calcium from the gastrointestinal tract and that excessive amounts of wheat bran can cause a negative calcium balance.

Extension conducts nutrition education programs designed to help people maintain health and well-being within the confines of family living, lifestyles, and budgets. Audiences include both the general public and high-risk subgroups such as pregnant women, infants and children, adolescents, the elderly, and low-income mothers. Over 10 million people are reached nationwide through nutrition education classes and programs.



Human nutrition research improves diet and health of people.



Nutrition programs help people maintain health.

The Expanded Food and Nutrition Education Program (EFNEP) helps low-income families and youth acquire knowledge, skills, attitudes, and changed behaviors leading to improved family diets and nutritional welfare. The 1985 program operated in 813 locations with 4,185 paraprofessionals providing direct nutritional training to over 224,000 adults and 428,000 youths. More than 50,000 volunteers assisted with program delivery. Since the program began, 2.5 million families have been helped.

**Rural Revitalization:** Extension programs are contributing to the revitalization of rural America. Off-farm employment is a critical component of the farm and rural economy as families and communities cope with changing economic and social conditions. In Montana and Wisconsin, Extension conducted intensive workshops and followup assistance on assessing financial conditions, handling stress, and formulating plans for farm and community businesses. Ohio implemented statewide economic development projects using business visitation teams and self-assessment to retain jobs and expand businesses. Ranchers in 19 Texas counties increased annual income from hunting and fishing leases by \$7 million.

Extension assists local governments through many management programs. The State of Massachusetts saved \$3.3 million through improved rural government debt management. Mississippi, Georgia, and Oklahoma Extension Services helped local governments improve public facilities, including transportation, medical services, and



Leadership programs provide training to community leaders.

solid waste handling. A Family Community Leadership program in six Western States and a six-State New England Rural Leaders program provided intensive training to 1,300 community leaders to help them become more effective public decisionmakers.

Nationwide, Extension has several programs dealing with family and community stress management. Over a dozen hotlines operated by Extension staff and volunteers across the country have responded to more than 13,000 callers seeking emotional support and legal and financial assistance. About 15 States have established special counseling centers with trained counselors and a strong network of mental health professionals, ministers, lawyers, and bankers to assist families in stress.

**4-H Programs Benefit Youth and Society:** Currently, over 4 million youth are involved in 8.5 million 4-H projects which draw on the knowledge resources of the land-grant universities and the U.S. Department of Agriculture. They are enriched by the personal involvement of 600,000 4-H volunteers and the strong contributions and involvement of business and industry. The real-life experiences in 4-H help youth become contributing members of society.

A random sampling of the adult population in the United States, conducted by the Texas Extension Service in 1985, showed that former 4-H members are more active in community activities, particularly leadership roles, than non-members. Former 4-H members gave higher rankings to personal development, knowledge transfer, leadership, and coping skills experiences than did former members of other organizations. Also, 4-H participants felt their overall experiences were more valuable than did participants of other youth organizations.

Relatively few young men and women fulfilled their career expectations. Half of the black grade school and high school males had aspired to professional and technical careers, while only 7 percent were actually working at such jobs 10 years later. Fewer white males expected to attain high-level jobs, but more actually attained them. Of the girls, 70 to 75 percent aspired to professional or technical careers; however, only 10 percent achieved their goals. The family, not ability or motivation, was the primary influence on whether the young people achieved their career goals.



Real-life experiences in 4-H help youth become contributing members of society.

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**Pesticide Residues in Foods, Dwellings, and the Environment:** Agricultural researchers in Florida completed numerous studies to determine the fate of toxicologically significant pesticides in the environment, in foods, and in dwellings. Such studies provided needed information on whether the pesticides were degraded to less toxic materials, whether levels persisted, and whether drinking water contained toxic levels of the pesticides. They provided information necessary to decide whether filters should be installed on wells contaminated with ethylene dibromide or whether new wells should be drilled to replace hundreds of contaminated wells in the citrus-growing regions of the State. They also showed that nearly 1,000 municipal and community wells throughout Florida were not contaminated. Analytical methods were developed for numerous pesticides which now allow for their analyses in a variety of food and environmental samples. Studies with chlordane and chlorpyrifos (termiticides) in dwellings showed that chlorpyrifos can be safely contained by plastic film vapor barriers beneath plenum (ductless) structures, whereas chlordane cannot.

**Volunteers and Extension—Partners in Action:** Extension studied volunteer efforts in a representative sample of 315 counties. When projected on a national basis, the results suggest that in 1 year, Cooperative Extension agents work with 2.9 million volunteers who, in turn, work with 48 million other adults and youth. Volunteers invest 51 days for every day an Extension professional works with volunteers. The value of volunteer time, if reimbursed at a wage equivalent to the work involved, would have been more than \$4.5 billion—nearly five times greater than the total combined Federal, State, and local budgets of the Cooperative Extension Service.

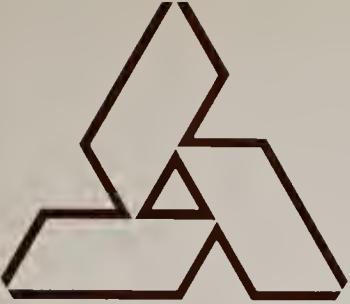
Volunteers are most apt to assist Extension with educational functions such as group instruction, answering individual questions, and assisting with media projects. Many volunteers work with Extension on community projects and help coordinate shows, fairs, and other major events. The 4-H program relies heavily on volunteers to work directly with youth or to serve in an advisory role for planning programs. With assistance from the Kellogg Foundation, 4-H has initiated a major effort to improve and increase its work with volunteers.

Extension Service, USDA



Nearly 3 million volunteers assist with Extension programs.





## Accomplishments of the Joint Council, National Committees, and Regional Councils

### Joint Council on Food and Agricultural Sciences

**Five-Year Plan for the Food and Agricultural Sciences Published:** The first biennial update of the Five-Year Plan was submitted to the Secretary of Agriculture and distributed throughout the food and agricultural science and education system in March 1986.

The Five-Year Plan is a conceptual plan, listing the kinds of science and education activities that will be necessary to solve the long-range problems facing food and agriculture that were identified in the Needs Assessment. The plan provides evidence that the decentralized research, education, and higher education system can plan together. It also:

- Provides a forum for the continued evaluation of goals and objectives.
- Provides a standard for evaluating progress.
- Serves as a planning aid for decisionmakers.
- Provides an accounting of human resource allocations and projections of anticipated changes and needs.

**Fiscal Year 1988 National Priorities Developed:** The Joint Council, involving its National Committees and Regional Councils, selected and ranked priorities for research, extension, and higher education. State, regional, and national perspectives were taken into consideration as the Joint Council ranked eight national priorities for fiscal year 1988. The priorities submitted to the Secretary of Agriculture were:

1. Enhance Profitability in Agriculture
2. Expand Biotechnology To Enhance the Benefits From Plants and Animals
3. Improve Water Quality and Management
4. Strengthen the Development of Professional and Scientific Expertise
5. Enhance Productivity and Conservation of Soils
6. Expand Domestic and Foreign Markets and Uses for Agricultural and Forest Products
7. Preserve Plant Germplasm and Genetically Improve Plants
8. Improve Human Nutrition and the Understanding of Diet/Health Relationships

**Major Issues/Topics Considered:** Issues and topics given special attention during the past year include:

- Food science and its relationships to other components of the food and agricultural system.
- Animal health and American agriculture linkages.

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- Rethinking the higher education system.
  - Project TOWARD 2005—Northeast agriculture, food, and forestry; Issues and opportunities.
  - Philosophy and strategy for allocation of resources to new initiatives.
  - New and alternative uses for farm and forest products.
  - Policies impacting science and education, with emphasis on scientific expertise development, facilities in the food and agricultural system, and competitive research grants.
  - International coordination and cooperation.
  - Application of electronic technology.
  - Coordination and linkages between university organizations and the Joint Council.
  - Trends in aquaculture development.
  - Home economics—meeting today's needs.
  - Analysis and response to the study, "The Agricultural Technology Delivery System."
  - Social science research issues and rural development.
  - Review and response to the USDA Technology Transfer Assessment Plan.
  - Exporting U.S. grain.
  - EPCOT center - "The Land" exhibit.

#### National Agricultural Research Committee

The National Agricultural Research Committee continued its role of coordinating and encouraging joint research planning among its State and USDA member organizations. The 24 members of the committee represent more than 140 State and Federal units engaged in agricultural research. To broaden input from the private research sector, representation from the Agricultural Research Institute was expanded to three members.

Uppermost in the minds of all members was the farm crisis and what research might contribute most to its resolution. Despite retrenchments in research capacity caused by State budget deficits and shrinking buying power of Federal resources, most State units redirected resources to address the crisis, as did Federal units. State and Federal units alike struggled to initiate or expand investigations into promising areas of the future such as biotechnology, genetic engineering, international trade policy, computer-based information systems, expert systems, and robotics, while maintaining the strength of their base programs.

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In its September 1985 meeting, the Committee heard reports from its member organizations, from congressional committees, and from research groups addressing such issues as: (1) the impact of bovine growth hormone on the U.S. dairy industry, (2) the effects of emerging technologies on the structure of agriculture, and (3) forestry technology. Also discussed were the current national research efforts in regional and national analyses, evaluation, planning, and financing which are being conducted through Interregional Project 6.

Many noteworthy planning and assessment activities of member organizational groups occurred during the year. These include:

- The planning committee for the State Experiment Stations (ESCOP) continued efforts initiated in the national "Symposium on the Research Agenda for the State Agricultural Experiment Stations" in June 1985. In two workshops in late 1985, ESCOP identified and described "Research Initiatives: A Research Agenda for the State Agricultural Experiment Stations."
- Researchers in the forestry schools and State Agricultural Experiment Stations identified priority concerns in "University-Based Forestry Research: Unlocking the Future." Wood utilization priorities were a special focus of a planning meeting in October 1985.
- Scientists in home economics and related disciplines reviewed several decades of research on strengthening of human resources at a symposium in March 1986. The research, especially that derived from agricultural experiment station support, was assessed not only from the standpoint of accomplishments but also to identify future areas for investigation.
- A committee of the Board on Agriculture, National Research Council, identified research priorities and needs of the Colleges of Veterinary Medicine and other animal health research units.
- The historically black 1890 institutions summarized research activities and highlighted needs in "Progress and Productivity Through Research and Service."
- The Economic Research Service (ERS) conducted its annual planning conference and launched a new 5-year, 5-point program built around redirecting ERS resources to meet high-priority needs.
- The Forest Service completed an update of its recommended renewable resources program for the years 1985 to 2030. The planned research program stresses coordinated activities with States, universities, and private industry. New high-priority research initiatives, such as biotechnology, effects of atmospheric deposition, and integrated forest pest management, will be phased into the Forest Service's base research program as funding permits.
- The Agricultural Research Service (ARS) published a revision of the 6-year implementation plan (1986-1992) describing its goals, objectives, and broad research approaches. The plan discusses the agency's revised management philosophy and summarizes program priorities that ARS will use in allocating its resources.

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<b>National Higher Education Committee</b>	<p>During the year, the National Higher Education Committee actively contributed information to the Joint Council and interacted with the Council on the topics of the image of higher education, recruitment, and curriculum.</p> <p>From its constituency groups from agriculture, forestry, home economics, and veterinary medicine, the committee received 46 nominations for the 1986 Accomplishments Report. Fourteen of these examples were submitted to the Joint Council, including accomplishments from across the Nation in course and curriculum development, student recruitment, and faculty development programs.</p> <p>Priorities in higher education for the 1988 Priorities Report were ranked by the committee and submitted to Joint Council. The major objective of the recommended priorities is to meet the ongoing need in the food and agricultural sciences for qualified professionals and scientists. The committee selected as its highest priority the attraction of outstanding students to the food and agricultural sciences, particularly in areas characterized by current or projected shortages.</p> <p>Representatives of the committee met with the Joint Council to discuss the topic "Rethinking Our Higher Education System." Presentations were made relative to future trends and issues in higher education, including the challenge of curricula change. Of particular interest were experiences and impressions presented by two recipients of the USDA National Needs Fellowship Program. The Joint Council's response to the presentations and discussion was positive and supportive.</p> <p>As a major continuing effort, a subcommittee is contributing to a draft of a brochure tentatively entitled "Educating Scientists and Professionals: Achievements and Agenda for Food and Agricultural Sciences Higher Education." This publication will focus on the issues which must be dealt with in order to strengthen the Nation's food and agricultural sciences higher education system.</p>
<b>National Extension Committee</b>	<p>The National Extension Committee addressed the following issues during the past year:</p> <ul style="list-style-type: none"><li>• Agricultural profitability/management systems;</li><li>• Improving water quality and management;</li><li>• Preparing Extension professionals for the future; and</li><li>• Recruitment of students to agriculture.</li></ul> <p>Agricultural profitability aspects that were considered included a nationwide overview; firsthand reports from specialists working with the profit-focused Arkansas rice production system; and forward-looking aspects of Extension/research linkage. The Committee received a special report on ECOP/ESCOP efforts to improve ground-water quality. Major presentations and discussions were held on challenges and problems associated with preparing Extension professionals to develop and deliver Extension programs in emerging areas. The Chair of the National Higher Education Committee (NHEC) briefed the Committee on the developing critical shortage of agricultural professionals. Interaction between the NHEC and NEC is continuing in this area, focused on recruiting students to agriculture.</p>

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The National Extension Committee supported the Joint Council reports through the development of Extension priorities and accomplishments. Input was solicited from the Extension Committee on Organization and Policy and the National Extension Advisory Council in developing priorities reflective of the Extension system. Extension accomplishments were documented through the computerized Narrative Accomplishment Reporting System.

Interaction with the Users Advisory Board was assured through the establishment of a permanent liaison between the UAB and the Committee. Contact continued with the Northeast Regional Council's Toward 2005 project and the committee received a special report on that program. Other special reports included a review of the Extension Service/USDA budget for fiscal year 1987. The Committee reviewed the Extension programs and also reviewed the Office of Technology Assessment report on technology, public policy, and the changing structure of American agriculture.

#### **Northeast Regional Council**

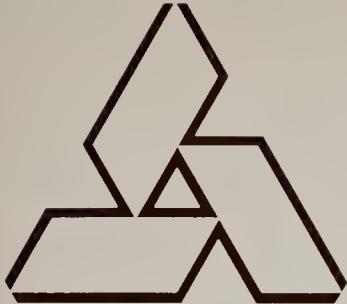
The Northeast Regional Council's major focus for fiscal year 1986 has been on the *Project Toward 2005: Northeast Agriculture, Food, and Forestry; Issues and Opportunities*. The primary objective of Toward 2005 is to identify substantive issues and to articulate alternative courses of action that will help assure a desirable future in the Northeast agriculture, food, and forestry industries. The project has proceeded under the direction of a Steering Committee, chaired by Dr. Gilbert Porter of Agway, and an Executive Director, Dr. Mark Bailey. The project has operated with three task forces. The charge of Task Force I is to collect, organize, and analyze current data and develop relevant projections. Task Force II will relate Task Force I's projections to the agricultural, food, and forestry industries. The role of Task Force III is to analyze the current state of the agricultural, food, and forestry sciences research, education, and extension systems relative to the projections and impacts developed by Task Forces I and II. The draft reports of the Task Forces have been reviewed by the Future Board to help assure that the yield of the Project is visionary, balanced in perspective, broad (system-oriented) in its coverage, technically sound, and reasonable. Agricultural and educational leaders throughout the Northeast have reviewed initial findings and have made valuable input into the project's final report. The Toward 2005 project report is scheduled to be finalized in early 1987.

Obviously, Toward 2005 is the primary agenda item for the Northeast Regional Council at this time. The Council is discussing how the project will be implemented after the report is released. Funding for the continuation of the project is a major concern.

Other agenda items addressed by the Northeast Regional Council included the development of a clearly defined mission statement for the Council, especially the need for greater representation from the private sector; and the implementation of an ongoing systematic process for determining regional priorities. Action was initiated on these items at the Council's May 1986 meeting and will be discussed further at the December meeting.

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<b>Western Regional Council</b>	The Western Regional Council met once during 1986 to develop the 1988 priorities report for the Western Region. With the assistance of subcommittees involving the Western Agriculture Research Committee, the Western Extension Committee, and the Western Higher Education Committee, the Council identified priority areas for future attention. The Western Regional Council is coordinating its efforts with the Council of Administrative Heads of Agriculture and all of the committees to develop a western regional meeting on priorities during 1987. This will allow the committee to better identify priority areas for the ensuing years.
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## Appendices

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### Appendix 1

#### Joint Council Priorities for Research, Extension, and Higher Education and Five-Year Plan Categories

##### Priorities<sup>1</sup>

1. Increase agricultural profitability through management
2. Improve water quality and management
3. Expand biotechnology efforts on plants, animals, and microbes
4. Develop necessary scientific and professional human capital
5. Improve human nutrition and understanding of diet/health relationships

##### Five-Year Plan Categories<sup>2</sup>

###### Special Categories

Farm and Ranch Profitability  
Diet, Health, and Food Production and Processing Systems  
Biotechnology in Agriculture  
Equipment and Facilities

###### Subject-Matter Categories

Professional Expertise in Agriculture  
Soil, Water, and Air  
Forest, Range, and Wildlife  
Crop Production Systems  
Animal Production Systems  
Processing, Marketing, and Distribution  
Human Nutrition  
Agriculture and Resource Policy  
Families and Consumers  
Youth  
Community and Rural Development  
Information Systems and Communications  
Technology  
International Science and Technology

<sup>1</sup>From "Fiscal Year 1987 Priorities for Research, Extension, and Higher Education: A Report to the Secretary of Agriculture." June 28, 1985. 43 pp. (Priorities established by the Joint Council in 1985 for recommended use in budget planning for fiscal year 1987).

<sup>2</sup>From "Five-Year Plan for the Food and Agricultural Sciences: A Report to the Secretary of Agriculture." March 1986. 97 pp.

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## Appendix 2

### The U.S. Food and Agricultural Science and Education System

#### Cooperative State Institutions:

- Land-grant colleges or universities in each State, as authorized in 1862, plus 16 colleges of 1890 and Tuskegee University, have programs of higher education in the food and agricultural sciences.
- Fifty-eight State agricultural experiment stations (many with networks of substations), plus 17 schools of forestry and certain schools of home economics and veterinary medicine conduct research programs partially supported by Federal formula funds. Research investment (all sources) was \$1.1 billion in fiscal year 1985 involving 7,475 scientist years (SY) of research effort.
- Cooperative Extension Services exist in all 50 States plus the District of Columbia and U.S. territories. With total funding at approximately \$1.0 billion last year, Cooperative Extension programs involved over 16,000 professional staff years, plus nearly 4,000 paraprofessional staff years, and significant inputs by over 2.9 million volunteers trained and supervised by professional staff.

#### USDA Research and Education Agencies:

- The Agricultural Research Service allocated \$499.7 million in fiscal year 1986. Research is conducted at 135 locations in the United States and abroad involving 2,666 SY's.
- The Cooperative State Research Service channels most of its funds—\$285 million in fiscal year 1986—to the cooperating State research system on a formula basis; it also includes competitive and special research grants and Federal administration. The Office of Grants and Programs Systems during fiscal year 1986 administered \$43.7 million in Competitive Research Grants for several research programs in Science and Education. Higher Education Programs administered about \$6 million for programs designed to strengthen scientific and professional expertise.
- The National Agricultural Library, funded at \$10.8 million in fiscal year 1986, provides wide-ranging library and technical information services.
- The Economic Research Service, with funding of \$46 million for fiscal year 1986, accounts for about 500 SY's of economic and social science research and analysis.
- The Forest Service (research divisions), with funding of \$120 million (including \$6.5 million in support of a Competitive Forestry Research Grants Program) in fiscal year 1986, provided about 750 SY's of research in resource management and utilization plus resource protection functions.

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### **Other Colleges and Universities:**

- Approximately 200 other State-supported colleges or universities, including 65 with baccalaureate agricultural degrees, conduct programs of higher education, research, and outreach in food and agricultural sciences.
- Other USDA agencies have limited but direct research and education roles:  
Office of International Cooperation and Development  
Soil Conservation Service  
Agricultural Marketing Service  
Office of Transportation  
Agricultural Cooperative Service  
National Agricultural Statistics Service  
Human Nutrition Information Service

### **Other Federal Agencies:**

- At least 14 Federal departments, commissions, and independent agencies besides USDA conduct research and education programs closely related to agriculture and forestry or provide funds to support programs in the USDA-State system. These include:  
Department of Health and Human Services, through the National Institutes of Health  
Department of the Interior  
Department of State, through the Agency for International Development  
Department of Commerce  
National Science Foundation

### **Private Firms:**

- Research and development (R&D) are performed by equipment, seed, fertilizer, and other input suppliers; producing, food and fiber processing, and distributing operations; and specialized private R&D firms. A recent survey published by the Agricultural Research Institute (July 1985) estimates annual research expenditure by private industry at \$2.1 billion.
- Field personnel and information specialists employed by vendors of food and agricultural supplies, equipment, and services disseminate technical information to farmers and to processors and distributors of agricultural commodities. Consumer service departments of most major food processors develop and deliver a wide variety of nutritional and technical information to consumers. Publications related to agriculture, as well as radio and TV, provide timely information which is widely used by those engaged in food and fiber production and processing, and is of interest to many consumers.

### **Other Private Organizations:**

- Foundations or similar organizations facilitate or channel funds to research and/or educational programs in the public sector.
- Associations formed by private firms conduct research and/or educational programs for their members.

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## Appendix 3

### Members of the Joint Council on Food and Agricultural Sciences

#### LAND-GRANT COLLEGES

##### *Administrative Heads of Agriculture:*

Dr. James H. Anderson\*  
Vice Provost and Dean, College of  
Agriculture & Natural Resources  
Michigan State University  
East Lansing, MI 48824

##### *Forestry:*

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College Station, TX 77843

##### *Extension (ECOP):*

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103 Roberts Hall  
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Ithaca, NY 14853

##### *Resident Instruction (RICOP):*

Dr. Joseph E. Kunsman, Jr.\*  
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University of Wyoming  
Laramie, WY 82071

Dr. Gerald L. Zachariah  
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Institute of Food & Agr'l. Sciences  
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##### *Research (ESCOP):*

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\*Members of the Executive Committee

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*Home Economics:*

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*National Agricultural Research & Extension  
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## **Appendix 4**

### **National Committee and Regional Council Chairs**

#### **National Agricultural Research Committee**

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College Station, TX 77843

Dr. Terry B. Kinney, Jr. (Cochair)  
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#### **National Extension Committee**

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Dr. Henry Wadsworth (Vice Chair)  
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Cooperative Extension Service  
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#### **National Higher Education Committee**

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#### **North Central Regional Council**

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#### **Northeast Regional Council**

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#### **Southern Regional Council**

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Associate Director  
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#### **Western Regional Council**

Dr. Larry Branen  
Dean, College of Agriculture  
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